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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
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10/828,592

04/21/2004

Betty Shu Mercer

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EXAMINER

FULK, STEVEN J

ART UNIT

PAPER NUMBER

2891

NOTIFICATION DATE

DELIVERY MODE

06/09/2008

ELECTRONIC

**Please find below and/or attached an Office communication concerning this application or proceeding.**

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

uspto@ti.com  
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<b>Office Action Summary</b>	<b>Application No.</b>	<b>Applicant(s)</b>	
	10/828,592	MERCER ET AL.	
	<b>Examiner</b>	<b>Art Unit</b>	
	Steven J. Fulk	2891	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

#### Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

#### Status

- 1) ☒ Responsive to communication(s) filed on 04 March 2008.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

#### Disposition of Claims

- 4) ☒ Claim(s) 1-6,8-16 and 18-22 is/are pending in the application.
- 4a) Of the above claim(s) 11-15 is/are withdrawn from consideration.
- 5) ☐ Claim(s) \_\_\_\_\_ is/are allowed.
- 6) ☒ Claim(s) 1-6,8-10,16 and 18-22 is/are rejected.
- 7) ☐ Claim(s) \_\_\_\_\_ is/are objected to.
- 8) ☐ Claim(s) \_\_\_\_\_ are subject to restriction and/or election requirement.

#### Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 21 April 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.  
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).  
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

#### Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some \* c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
  2. ☐ Certified copies of the priority documents have been received in Application No. \_\_\_\_\_.
  3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

\* See the attached detailed Office action for a list of the certified copies not received.

#### Attachment(s)

- |  |   |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892)          | 4) <input type="checkbox"/> Interview Summary (PTO-413)           |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | Paper No(s)/Mail Date. _____                                      |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO/SB/08)          | 5) <input type="checkbox"/> Notice of Informal Patent Application |
| Paper No(s)/Mail Date _____  | 6) <input type="checkbox"/> Other: _____                          |

## **DETAILED ACTION**

### ***Claim Rejections - 35 USC § 102***

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. Claims 1, 2, 4-6, 9, 10, 16, 19 and 20 are rejected under 35 U.S.C. 102(b) as being anticipated by Kondo et al. '858.

Regarding claims 1 and 16, Kondo discloses a method for manufacturing an integrated circuit (figs. 7A-7E), comprising: forming transistor devices over a semiconductor substrate (101; col. 3, lines 40-41, substrate contains transistor devices); forming one or more metallization layers over the transistor devices, the one or more metallization layers interconnecting one or more of the transistor devices (transistors in substrate would inherently be wired to bond pad 103 through metallization layers); forming a protective overcoat (104) over the one or more metallization layers, wherein the protective overcoat has an opening located therein; forming a surface conductive lead (fig. 7D, 108) in the opening formed within the protective overcoat and over a barrier layer (105), the barrier layer providing additional adhesion between the protective overcoat and the surface conductive lead (layers 104-108 are the same materials disclosed by the applicant, therefore the adhesion properties are the same as claimed); a portion of the barrier layer extending beyond the surface conductive lead (fig. 7D); providing a seed layer directly contacting the barrier layer (seed layer 106/107

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directly contacts barrier layer 105; Applicant's definition of a seed layer includes a multi-layer seed layer, Specification, Paragraph [0032]) and at least partially within the opening of the barrier layer; subjecting the portion of the barrier layer to a dry etch to remove the portion and form a skirt (fig. 7E; col. 10, lines 33-39; col. 7, lines 65-67, diameter of barrier layer is larger than surface lead), the dry etch selective to the barrier layer (layer 105 is etched while underlying layers 104, 101, etc are not); and subjecting the seed layer to a wet etch prior to subjecting the portion of the barrier layer to the dry etch (col. 9, lines 23-25), wherein the wet etch is without substantially undercutting the etched seed layer or surface conductive lead (fig. 7E; col. 9, lines 23-35, etching of seed layer is selective and does not etch barrier layer, thus substantially no undercutting of the seed layer or surface conductive lead occurs).

Regarding claims 2 and 4, the reference discloses the dry etch to comprise carbon tetrafluoride and chlorine.

Regarding claim 5, the reference discloses the barrier layer to be a tungsten-titanium barrier layer (col. 7, lines 11-12).

Regarding claim 6, the reference discloses the barrier layer to have a thickness ranging from 200 to 300 nm (col. 8, lines 62-65).

Regarding claims 9 and 19, the reference discloses the surface conductive lead to have a width ranging from 3 to 200  $\mu\text{m}$  (col. 4, lines 20-21).

Regarding claims 10 and 20, the reference discloses the protective overcoat to comprise one or more layers selected from the group consisting of silicon oxide layers,

and silicon nitride layers and phospho-silicate glass layers (col. 3, lines 56-62; col. 7, lines 36-49).

***Claim Rejections - 35 USC § 102/35 USC § 103***

1. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

2. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

3. Claims 1 and 16 are rejected under 35 U.S.C. 102(b) as being anticipated by Lee et al. '692 or, in the alternative, rejected under 35 U.S.C. 103(a) as being unpatentable over by Lee et al. '692 in view of Bojkov et al. '048.

Regarding claims 1 and 16, Lee '692 discloses a method for manufacturing an integrated circuit (figs. 7-14), comprising: forming transistor devices over a semiconductor substrate (fig. 7, substrate 10; ¶10, integrated circuits in substrate); forming one or more metallization layers over the transistor devices, the one or more

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metallization layers interconnecting one or more of the transistor devices (§12, integrated circuits connected to bond pad 32 through metal layers); forming a protective overcoat (34) over the one or more metallization layers, wherein the protective overcoat has an opening located therein; forming a surface conductive lead (fig. 9, 38) in the opening formed within the protective overcoat and over a barrier layer (36), the barrier layer providing additional adhesion between the protective overcoat and the surface conductive lead (layers 34/36/38 are the same materials disclosed by the applicant, therefore the adhesion properties are the same as claimed), a portion of the barrier layer extending beyond the surface conductive lead (fig. 9); providing a seed layer (§82) directly contacting the barrier layer and at least partially within the opening of the barrier layer; subjecting the portion of the barrier layer to a dry etch to remove the portion and form a skirt (fig. 14; anisotropic dry etch results in skirt extension of barrier layer past surface conductive lead), the dry etch selective to the barrier layer (layer 36 is etched while underlying layers 34, 30, etc are not); and subjecting the seed layer to a wet etch prior to subjecting the portion of the barrier layer to the dry etch, (§94; fig. 12, partial etching of copper surface conductive lead 38 by wet etch would inherently remove the copper seed layer to expose barrier layer for subsequent etching in fig. 14), wherein the wet etch is without substantially undercutting the etched seed layer or surface conductive lead (fig. 12, wet etch is selective to the copper seed/conductive lead layers, and does not remove barrier layer 36, thus no substantial undercutting of the seed layer or surface conductive lead occurs). See Erdos '071 for evidence that etching a surface lead and seed layer comprising the same material will result in removal of the seed

layer and thinning of the surface conductive lead (Erdos, col. 4, lines 1-9), and the etch also exposes the barrier layer for subsequent etching.

Alternatively, assuming *arguendo* that it was not inherent to remove the seed layer when partially etching the surface conductive lead, it would nonetheless have been obvious to one of ordinary skill in the art to remove the seed layer by wet etch. Bojkov teaches a method of manufacturing an interconnect comprising forming a surface conductive lead (fig. 4, 301) in an opening formed within a protective overcoat (102); the lead formed over seed layer (105a/105b); and subjecting the seed layer to a wet etch (¶34; Bojkov also teaches this etch will remove portions of the surface conductive lead 301, providing further evidence of the inherency argument above). Further evidence of obviousness of using a wet etch to remove the seed layer is provided by Applicant's Admitted Prior Art, stating that wet etching is a well known, effective method of removing the seed layer (Specification, page 2).

Therefore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to remove the seed layer by wet etch. One would have been motivated to do this because wet etching was a well known, conventional method of removing metal layers in semiconductor devices that provided the advantages of low cost and simple processing.

### ***Claim Rejections - 35 USC § 103***

4. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the

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subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

5. Claim 3 is rejected under 35 U.S.C. 103(a) as being unpatentable over Kondo et al. '858 in view of Ashby et al. '238.

Kondo teaches all of the elements of the claims as set forth in paragraph 2 above, but the reference does not explicitly teach the use of nitrous oxide in the dry etch chemistry. Ashby et al. teaches a method of etching tungsten titanium alloys (col. 4, lines 2-6) using a dry etch chemistry of carbon tetrafluoride and nitrous oxide, oxygen or chlorine (col. 4, lines 58-65; col. 6, lines 29-47) in the fabrication of integrated circuits (col. 4, lines 31-42).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to use the dry etch chemistry of Ashby et al. in the method for manufacturing an interconnect of Kondo. One would have been motivated to do this because Kondo taught that it was desirable to use a conventional dry etch that included  $\text{Cl}_2$ ,  $\text{BCl}_3$ ,  $\text{CF}_4$ , or the like (col. 10, lines 35-39), and Ashby et al. taught that a dry etch chemistry of carbon tetrafluoride and nitrous oxide, oxygen or chlorine was well known to be highly selective to the tungsten titanium alloy, thus removing the barrier layer without damaging the surrounding layers of the device (Ashby et al., col. 2, lines 40-52).

6. Claims 8 and 18 rejected under 35 U.S.C. 103(a) as being unpatentable over Lee et al. '692 in view of Bojkov et al. '048.



Lee or Lee in view of Bojkov teaches all of the elements of the claims as set forth in paragraph 5 above, but Lee does not explicitly disclose the wet etch chemistry to include hydrogen peroxide and sulfuric acid. Bojkov teaches a method of etching the copper seed layer using a wet etch chemistry including hydrogen peroxide and sulfuric acid (§34).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to use the wet etch chemistry of Bojkov in the method for manufacturing an interconnect as described by Lee or Lee in view of Bojkov. One would have been motivated to do this because Bojkov taught that a wet etch chemistry including hydrogen peroxide and sulfuric acid was a well known, convenient chemistry used to etch copper seed layers (§34). Further evidence of obviousness of using a chemistry including hydrogen peroxide and sulfuric acid is provided by Backus '124, which taught that a wet etch chemistry including hydrogen peroxide and sulfuric acid (col. 2, lines 43-51) was a well known chemistry used to etch copper that also prevented cementation of copper onto other metal surfaces during etching (col. 1, lines 28-35), thus providing a clean surface conductive lead for subsequent wire-bonding and packaging steps.

9. Claims 21 and 22 are rejected under 35 U.S.C. 103(a) as being unpatentable over Kondo et al. '858 in view of Nye, III et al. '286.

Kondo discloses all of the elements of the claim(s) as set forth in paragraph 2 above, including etching the barrier layer with a dry etch comprising carbon tetrafluoride

to form a skirt, but the reference does not explicitly disclose the resulting skirt to taper down as it moves away from the surface conductive lead.

Nye teaches a method for manufacturing an interconnect for an integrated circuit, comprising forming transistor devices over a semiconductor substrate (fig. 4A, substrate 200); forming one or more metallization layers over the transistor devices, the one or more metallization layers interconnecting one or more of the transistor devices (metallization 210); forming a protective overcoat (layer over 210) over the one or more metallization layers, wherein the protective overcoat has an opening (215) located therein; forming a surface conductive lead (300) in the opening formed within the protective overcoat and over a barrier layer (240), a portion of the barrier layer extending beyond the surface conductive lead (fig. 4A, layer 240 tapers out away from 300); providing a seed layer (260/280) directly contacting the barrier layer and at least partially within the opening of the barrier layer; subjecting the portion of the barrier layer to a dry etch comprising fluorocarbons to remove the portion and form a skirt that tapers down as it moves away from the surface conductive lead (fig. 4A; col. 6, lines 29-37 & 63-65), the dry etch selective to the barrier layer (fig. 4A, layers under 240 are not etched).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the tapered skirt of Nye in the method of Kondo. One would have been motivated to do this because Nye taught that the barrier layer edge should have a tapered profile in order to minimize stress induced cracks in the underlying insulators (Nye, col. 6, lines 33-37).

***Response to Arguments***

10. Applicant's arguments with respect to the rejection of claims 1, 2, 4-6, 9, 10, 16, 19 and 20 under 35 U.S.C. 102(b) as being anticipated by Kondo '858 have been fully considered but they are not persuasive. Applicant argues that Kondo does not teach providing a seed layer that directly contacts the barrier layer. This is not found persuasive because Applicant's definition of a seed layer includes a multi-layer seed layer, therefore layers 106/107 of Kondo are considered a seed layer which is directly in contact with barrier layer 105.

Applicant also argues that Kondo does not teach forming a barrier layer to provide additional adhesion between the protective overcoat and the surface conductive lead. This argument is not persuasive because the overcoat material (oxide or nitride) and barrier material (tungsten-titanium) of Kondo are the same materials as disclosed by the applicant, and therefore would inherently perform the same function of improving the adhesion between the protective overcoat and the surface conductive lead.

11. Applicant's arguments with respect to the rejection of claims 1 and 16 under 35 U.S.C. 102(b) as being anticipated by Lee '692, or as being unpatentable over Lee in view of Bojkov '048, have been fully considered but they are not persuasive. Applicant argues that Lee does not disclose forming a barrier layer to provide additional adhesion between the protective overcoat and the surface conductive lead. This argument is not persuasive because the overcoat material (nitride) and barrier material (tungsten-titanium) of Lee are the same materials as disclosed by the applicant, and therefore

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would inherently perform the same function of improving the adhesion between the protective overcoat and the surface conductive lead.

Applicant also argues that the wet etch of Lee undercuts the surface conductive lead 38, whereas the present invention using a wet etch to etch the seed layer without substantially undercutting the etched seed layer or surface conductive lead. This argument is not found persuasive. Paragraph [0036] of the specification states: "Notice how the wet etchant typically used to etch the seed layer 410 does not substantially undercut the etched seed layer 610 or surface conductive lead 520. As the seed layer wet etch is selective to the seed layer 410, it does not substantially affect the barrier layer 310." Thus, undercutting of the seed layer/surface conductive layer is being defined as removal of the barrier layer during wet etching of the seed layer; in other words, because the barrier layer is not removed, there is no undercutting of the seed layer/surface conductive lead. Figure 12 of Lee shows the barrier layer 36 to be intact after the wet etch to remove the seed layer, thus no undercutting of the seed layer/surface conductive lead occurs.

Applicant also argues that Bojkov does not teach a barrier layer extending beyond the surface conductive lead. The Examiner was not relying on Bojkov to teach this limitation, as the barrier layer was disclosed by Lee. Instead, the Examiner was relying on Bojkov to show obviousness of removing the seed layer by a wet etch, as set forth in the rejection above.

***Conclusion***

12. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

13. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Steven J. Fulk whose telephone number is (571)272-8323. The examiner can normally be reached on Monday through Friday, 8:00am-5:00pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Bill Baumeister can be reached on (571) 272-1722. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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14. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

Steven J. Fulk  
Patent Examiner  
Art Unit 2891

May 23, 2008

/BRADLEY W BAUMEISTER/  
Supervisory Patent Examiner, Art Unit 2891